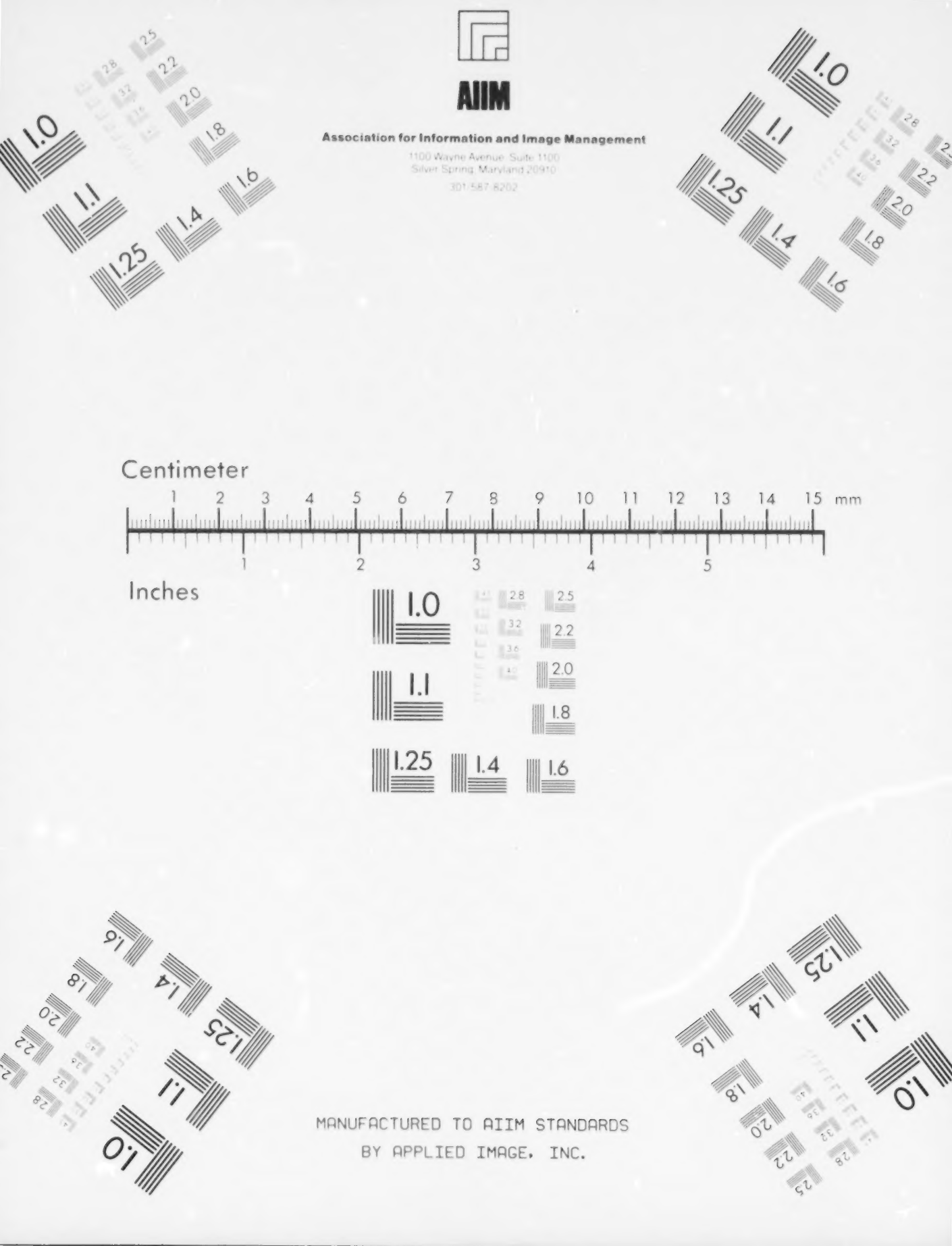
AIIM
Association for Information and Image Management
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202
Centimeter
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 mm
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G. H. MARKS

AUTHORS: Greenberg, J., Daniel, E., Massey, J. and White, P.

THE PLANT INFORMATION CENTER (PIC): A WEB-BASED LEARNING CENTER FOR BOTANICAL STUDY

ABSTRACT

The Plant Information Center (PIC) is a project funded under the Institute of Museum and Library Studies that aims to provide global access to both primary and secondary botanical resources via the World Wide Web. Central to the project is the development and employment of a series of applications that facilitate resource discovery, interactive learning, and contributory opportunities within the PIC system. Initial testing of PIC will be through sixth-grade science curriculum activities involving plant identification. On a larger scale, PIC intends to promote the flow of scientific information to researchers, amateur botanists, students (elementary through higher education), and other communities interested in botanical science. This paper provides an overview of PIC, reviews the development and implementation of PIC applications, and comments on the research activities that will measure the project's overall success.

INTRODUCTION

The networked environment enables scientific and cultural resource centers to provide access to primary resources and permits students, researchers, and the general public to visit, view, and experience virtually far more than they physically could in an entire lifetime. Within the context of digital libraries, students can now take "vicarious field trips" (Marchionini & Mauer, 1995) and access "rare and unique" resources on a daily basis. This can augment and enhance the experience garnered from an actual field trip to a museum or science center. Virtual field trips can, however, be limited by the absence of contextual features. An interactive lesson plan, the ability to communicate with classmates or subject experts via electronic means, or the option to contribute new knowledge to a resource center can greatly enrich the overall learning experience.

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Partnerships between resource centers and educators can enhance the traditional digital library model, and through a variety of applications provide a web-based learning center. This paper shows how one such partnership is developing applications, resources, and experience that will support a creative web-based learning environment.

WEB-BASED LEARNING CENTERS

The term digital library refers to electronic collections as well as digital resource centers with "fuller capabilities" (Borgman, 1999). Digital resource centers build on traditional library operations of collection development and reference assistance for all kinds of collections, with the goal of facilitating resource creation, enhancement, and use through interaction. Activities supported in this sophisticated digital library environment require the development of multiple applications. Within the educational arena, these developments underlie what might be more precisely defined as a web-based learning center.

Web-based learning centers include collections of digital resources that are augmented by the ability to conduct a variety of operations beyond mere search and retrieval. An example of this type of learning center is the Pennsylvania Educational Network Digital Object Repository (PEN-DOR) project (http://cumorah.sis.pitt.edu/pen_dor/start.htm). Central to PEN-DOR is a database of educational resources for both K-12 general education (e.g., math, science, history, social studies, English, and the arts) and Pennsylvania local and regional historical education. What distinguishes PEN-DOR from the more conservative view of a digital library is an interactive module and community memory reserve. PEN-DOR is supported by an application that enables teacher to build and modify existing lesson plans and share commentary on use of lesson plans via a community memory store.

The Plant Information Center (PIC) discussed in this paper is a web-based learning center that references a digital repository of botanical specimens collected for research purposes. PIC extends beyond the boundaries of a traditional library through a series of applications that support interactive learning, communication with botanical experts, and a channel for contributing resources and knowledge to PIC's information store.

THE PLANT INFORMATION CENTER (PIC)

PIC is a partnership of the North Carolina Botanical Garden, the University of North Carolina (UNC) Herbarium, the UNC School of Information and Library Science, the McDougle Middle School, and the Orange County, North Carolina, Public Library. A web-based educational initiative, PIC provides an integrated mechanism for botanical study by unifying resources and permitting access from numerous entry points. PIC includes a searchable database with digitized herbarium specimens (currently gymnosperms of the Southeast), a glossary of botanical terms, both print and electronic bibliographic resources that support botanical identification, and a list of web links to major virtual herbaria worldwide. PIC is in the process of developing an "Ask the Expert" application and an "Interactive Contributory Module" that will permit users to submit botanical resources to a community store. The contributory module will permit teachers to construct and share plant identification exercises and other lesson plans that work with PIC. An advisory group of fifteen members with expertise in the areas of science education, school media practices, botany and related sciences, database design, and digital photography have played an important role in PIC's development and continue to advise with a variety of ongoing activities.

PIC GOALS

PIC activities are supported by Institute of Museum and Library Service (IMLS), and are guided by four major goals:

- To create and test the interactive component of PIC for the general public within the context of the library environment and the public school system,
- To test the usefulness of digital images of herbarium specimens for plant identification and for inspiring the public and public school children with the aims and methods of professional botanical science,
- To demonstrate successful cooperation among the university, the public school system, and the public library in the development and implementation of a web-based learning center, and

- To develop educational experiences using virtual primary research materials from the herbarium for 6th grade students.

Project partners are working together to meet these objectives and to incorporate PIC into 6th grade curriculum activities that involve plant identification and larger questions about man's relationship to the natural world. PIC's long-term goals include making museum specimens and expert knowledge more widely available through the World Wide Web and promoting the flow of scientific information to researchers, amateur botanists, students (elementary through higher education), and other scientific communities interested in botanical science. Underlying these initiatives are a number of research goals addressing web-based educational initiatives that incorporate primary scientific source material for learning purposes. Through research and testing, the PIC team will explore image access and use, metadata issues, and electronic access to subject experts. Through publication and other communication means, the PIC team will make these research results available to the larger community that has implemented or is investigating the construction of a web-based learning center.

PIC ARCHITECTURE AND APPLICATIONS

PIC's architecture has four main components: 1.) a botanical specimen database, 2.) the Botanical Information Network (BOTNET), 3.) the "Ask the Expert" feature, and 4.) the "Interactive Contributory Module." Each one of these components represents a PIC application.

Database of Botanical Specimens

At the core of PIC is a relational database that links specimens and metadata. The database currently contains 500 images representing 50 taxa of gymnosperms (pines, spruces, firs, cedars, cypress) found in the Southeast. The database structure includes fifteen major classes that identify specimen nomenclature, link specimens to the classification authority (organization or individual), identify the specimen collection locale, document taxonomic changes in plant classification, and record digital processing information pertinent to archival images of each specimen. One central component of the

database is the specimen class. This includes a number of useful attributes, such as specimen title and class; the name of the specimen collector and his/her unique identification collector number; the country, state, county, city, elevation, and other specimen collection location data; the date the specimen was collected and the condition of the specimen; and the data the specimen documentation was modified.

The database developed in Microsoft ACCESS permits a user to query using a variety of criteria, such as collector name, specimen genus, common name, locale where specimen was collected and so forth. Working with database forms, data-imputers transcribe specimen metadata from digitized copies of the original specimen labels. Data-imputers are assisted by drop down menus and the UNC Herbarium Code Book (2000). The creation of active server pages permits the database to be accessed from the World Wide Web platform. Searching activities are supported by a series of Standard Query Language (SQL) constructed queries, which can easily be enhanced, modified, or developed as needed. The ease with which 6th grade students and other general users can use the standard queries and create their own will be tested.

Botanical Information Network

A predecessor project, BOTNET (Botanical Information Network), a virtual herbarium, is ongoing and provides a major research base for PIC to draw from. Herbaria are collections of dried and pressed plant specimens that document botanical life from around the globe (Radford, 1986). The proliferation of the World Wide Web has permitted the development of virtual herbaria, although none are extensive at this point. Two leading virtual herbaria are the Harvard University's Herbaria project (http://www.herbaria.harvard.edu/5million/) and the Missouri Botanical Garden's w-3-Tropicos database (http://mobot.mobot.org/Pick/Search/pick.html). Virtual herbaria provide scientific researchers and other user communities with specimen access on a global scale. These projects are significant because they preserve collection integrity by providing access to virtual specimens, while protecting the original.

BOTNET was initially constructed with funds from the University of North Carolina's Technology Development Program. It consists of resources that botanists

require to conduct plant identification activities (Murphy, 1997). BOTNET includes virtual specimens accessible via the Access database. BOTNET also includes two Hypertext Markup Language (HTML) applications; one for web accessible taxonomic schema and one for a web accessible plant glossary (e.g., Radford, et al, 1976). The BOTNET application is being enhanced via the PIC program.

Ask the Expert

The "Ask The Expert" component is a web-based application that facilitates communication between PIC users and botanical experts. A web-based form written in Perl script will permit users to submit general botanical and PIC-specific queries to an electronic bulletin board. PIC users can respond to the query through the form, and the response will also be posted on the electronic bulletin board. Botanical experts will respond to queries through a second form in a way that will ensure that authoritative answers are given to users. The expert answers will be posted to the electronic bulletin b[illegible] in a different color to distinguish them from the initial query and answers coming from other PIC users. The electronic bulletin board model was selected for this feature because queries will come from PIC users working in the public library, academic or research center, or public school setting, where individuals do not necessarily have electronic mail access. If the PIC user provides an e-mail address with his/her query, the expert reply will automatically be sent to the given address as well as to the electronic bulletin board. Sharing queries and answers via this application will document PIC use and provide a community information store that will assist in the compilation of frequently asked questions (FAQ) document, which will also be incorporated into the PIC framework.

Interactive Contributory Module

The Interactive Contributory Module is designed so that PIC users can submit additional botanical resources to a community store. Resources can be in the form of atomic objects (a digitized photograph, audio clips, or textual document), a collection of objects, or a lesson plan. This module is under construction and consists of an HTML

form, an Extensible Markup Language (XML) Document Type Definition (DTD) for a metadata schema, and an XML database. The HTML form permits the contributor to upload the resource with accompanying metadata. The metadata schema used in this project is based on the Dublin Core Metadata Element Set (http://purl.org/dc), an international and interdisciplinary schema designed to facilitate resource discovery of electronic resources on the World Wide Web. The metadata schema for this application differs from the Dublin Core in that it includes elements specific to the identification of botanical resources, such as family, genus, and species name. Once uploaded through the HTML form, a CGI (Common Gateway Interface) script processes the metadata and the resource for inclusion in the XML structured database. The XML database is distinct from the PIC central database, because resources are not from the UNC Herbarium and because the contributors/resource creators produce the metadata rather than information science and botanical documentation experts. To insure database integrity, quality control measures will be implemented. This module will allow teachers to build lesson plans by integrating specimens from PIC's central database and resources from the XML database. The XML framework will permit experimenting with partitioning the database into separate units for atomic objects, collections of objects, lesson plans for access purposes.

PIC RESEARCH

During the last few years there has been a tremendous increase in educationally-based digital projects (e.g., the University of Michigan Digital Library project: http://www.si.umich.edu/UMDL/, Carnegie Mellon University Informedia project: http://informedia.cs.cmu.edu/ SMETE Digital Library Information Portal: http://www.smete.org). The success of these projects relies not only on the teachers and on student willingness to work with these tools, but also on efficient and effective resource access, quality metadata, and the ability to communicate with and benefit from the knowledge of human subject experts. PIC provides a prototype for investigating how to effectively develop, implement, and maintain a digital learning center that is comprised of virtual scientific specimens, textual documentation, glossaries, and an array of other resources, and that supports interactive communication and contributory activities. The

PIC team intends to evaluate the success of this project conducting research in the following three areas: 1.) image access and use, 2.) metadata effectiveness, and 3.) electronic access to subject expertise.

Image Access and Use

Most digital educational projects include image materials. Success with images depends on image upload time, the image's ability to serve as an independent resource, and the image's integration with textual or other resource types. The PIC team will investigate the relationship between image use and image download time. A botanical specimen identification study will be conducted by comparing the use of the following: 1.) textual materials found in the public library, 2.) textual materials supplemented by the PIC system, and 3.) PIC system exclusively. Research on image access and use will also examine how teachers integrate PIC images into their instructional plans.

Effective Metadata

Metadata is important to the PIC project because it facilitates resource discovery and use. Some examples of metadata for a botanical specimen are the scientific name, the geographic location where the specimen was collected, and the date the specimen was collected. Teachers, students, and other PIC users will search metadata records in PIC's central database and the XML contributory module via public interface that is similar to an online library catalog. Transaction logs will be kept in order to track metadata searching. Quantifiable research will be conducted to identify the metadata that is important for specimen access in the learning environment. This research will also help to improve the overall effectiveness of the PIC database metadata framework.

*Electronic access to subject experts.

While many digital educational projects include a communication with expert component, there is little research on the success of such features. PIC's "Ask the Expert" module will provide a data store for research in this area. Through content analyses of electronic postings and experts' responses, researchers will examine the

effectiveness of this type of feature within the PIC system and raise questions about the implications of this feature for the greater digital learning environment.

CONCLUSION

PIC intends to promote the flow of scientific information to communities interested in botanical science and to provide a learning tool for students studying botanical identification. The PIC project also provides a prototype system for studying the development and employment of a series of applications that facilitate resource discovery, interactive learning, and contributory opportunities within networked environment. Through research on image access and use, metadata effectiveness, electronic access to subject experts, and the development of tools for web-based learning centers, the PIC team will contribute knowledge about the overall construction and implementation of web-based learning centers.

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